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FINAL REPORT

SUBMITTED TO

UINTA NATIONAL FOREST,
PLEASANT GROVE RANGER DISTRICT

REGARDING

COPY

ESTABLISHMENT OF A LICHEN BIOMONITORING PROGRAM AND BASELINE AT SELECTED SITES IN THE UINTA NATIONAL FOREST

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INTRODUCTION

PROJECT OBJECTIVES:

1. Identify selected air quality biomonitoring reference sites along the Wasatch Front within the boundaries of the Uinta National Forest.

2. Collect, curate, and identify lichen species from various habitats and substrates at each reference site.

3. Identify 1-3 pollution-sensitive lichen species at each reference site. Collect enough tissue of one sensitive indicator species (approximately 6-10 grams dry weight) from each reference site for elemental analyses. rare species will not be sampled for analysis, but their distribution will be noted.

4. Determine baseline thallus concentrations of 20 potential pollutant elements (including sulfur, selenium, arsenic, copper, bromine, manganese, lead, vanadium, potassium, iron, etc.), using replicate samples of one documented pollution-sensitive species collected at each reference site. Samples will be analyzed using Proton Induced X-ray Emission (PIXE) techniques.

5. Prepare and submit a final report by 31 January 1996.

LICHENS AS BIOLOGICAL INDICATORS OF AIR QUALITY:

Protocol for using lichens as bioindicators of air quality is well documented (Fields & St. Clair 1984; St. Clair 1989; Richardson 1992). Hale (1983) noted that lichens have been used in three basic ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all (or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey along with elemental analyses of tissues from sensitive indicator species (St. Clair 1989; Wetmore 1989).

As lichens accumulate many different pollutants from atmospheric outwash, lichen tissues provide a record of the kinds and relative quantities of air pollutants in any particular airshed (Schutte 1977; Wetmore 1989; Rope & Pearson 1990) Pollutant accumulation patterns for specific elements have been monitored over time by correlating thallus growth rates and pollutant concentrations in excised portions of lichen thalli (Lawry & Hale 1981). Changes in lichen physiological processes indicate pollution-related damage long before other, more easily detectable factors such as changes in thallus color, morphology, or community structure become apparent (Fields & St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Rushforth et al. 1982; Wetmore 1989). As certain lichen species are inherently more sensitive to airborne contaminants, air quality can be effectively monitored by occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to original baseline data.

GENERAL HABITAT DESCRIPTION FOR THE WASATCH FRONT, UINTA NATIONAL FOREST:

Uinta National Forest is located in central Utah primarily in the Wasatch Mountains. The forest extends south from the Salt Lake-Utah County line to Nephi in Juab County. The western boundary of the forest runs along the foothills of the Wasatch Mountains while the eastern boundary extends to a point just beyond Strawberry Reservoir. A separate component of the forest

encompasses the Sheeprock Mountains located southwest of Utah Lake in Tooele County. Three class II wilderness areas are located within the forest boundaries (Lone Peak, Mount Timpanogos and Mount Nebo). The proximity of these three wilderness areas to the heavily urbanized Wasatch Front suggests potential for diminished air quality.

The western face of the Wasatch Mountains is steeply faulted and marks the eastern most range of the Basin and Range region of Utah. The Wasatch Range was originally thought to be a part of the Rocky Mountain complex; however, it has now been documented that the Wasatch Mountains which were formed during the late Cretaceous and early Tertiary, are actually much younger than the Rocky Mountain core.

Vegetation zones in the western half of the Uinta National Forest include, Pinyon-juniper woodland, mixed mountain brush located along the western slope of the Wasatch Mountains, riparian communities at the bottom of narrow west-facing canyons, subalpine communities upslope from the mixed mountain brush zone, and some limited alpine tundra sites at the top of the Wasatch Range.

LICHEN BIOMONITORING REFERENCE SITES ALONG THE WASATCH FRONT, UINTA NATIONAL FOREST:

A total of 11 air quality biomonitoring reference sites were established on the western edge of the Wasatch Mountains in the Uinta National Forest during the 1995 field season. Specifically, reference sites have been established at the following locations:

SITE #1: 30 May 1995. Utah, Utah County, Uinta National Forest: vicinity of Sterling Hollow, above U.S. Forest Service Trail #008. GPS reading: 40° 03.077' north latitude; 111° 32.261' west longitude. Elevation: 1676 m. (5500 feet).

SITE #2: 5 June 1995. Utah, Utah County, Uinta National Forest: Rock Canyon vicinity of Rock Canyon Campground. GPS reading: 40° 16.31' north latitude; 111° 36.6' west longitude. Elevation: 2225 m. (7300 feet).

SITE #3: 7 June 1995. Utah, Juab County, Uinta National Forest: Gardner Canyon, approximately 3 km east of Interstate Highway 15. GPS reading: 39° 45.212' north latitude; 111° 48.977' west longitude. Elevation: 1798 m. (5900 feet).

SITE #4: 20 June 1995. Utah, Utah County, Uinta National Forest: American Fork Canyon near Timpanogos Cave National Monument. GPS reading: 40° ~~16.31'~~ 26.14' north latitude; 111° ~~41.55'~~ 43.82' west longitude. Elevation: 1830 m. (6000 feet).

SITE #5: 21 June 1995. Utah, Utah County, Uinta National Forest: Lone Peak Wilderness Area, approximatley 0.5 km below Silver Lake. GPS reading: 40° 31.025' north latitude; 111° 39.660' west longitude. Elevation: 2560 m. (8400 feet).

SITE #6: 5 July 1995. Utah, Utah County, Uinta National Forest: Hobble Creek Canyon, Camel Pass. GPS reading: 40° 11.135' north latitude; 111° 33.925' west longitude. Elevation: 2469 m. (8100 feet).

SITE #7: 25 July 1995. Utah, Utah County, Uinta National Forest: Santaquin Canyon, vicinity of Tinny campground, Lower Water Hollow. GPS reading: 39° 54.083' north latitude; 111° 43.963' west longitude. Elevation 2347 m. (7700 feet).

SITE #8: 1 August 1995. Utah, Utah County, Uinta National Forest: South Fork, Provo Canyon, near head of Brunnell's Canyon. GPS reading: 40° 18.992' north latitude; 111° 34.802' sest longitude. Elevation: 2834 m. (9300 feet).

SITE #9: 8 August 1995. Utah, Utah County, Uinta National Forest: Timpanogos Mountain, 1 km north-west of North Fork Battle Creek Canyon. GPS reading: 40° 23.458' north latitude; 111° 40.644' west longitude. Elevation 2469 m. (8100 feet).

SITE #10: 15 August 1995. Utah, Utah County, Uinta National Forest: Timpanogos Mountain, Timpanogos Basin. GPS reading: 40° 24.122' north latitude; 111° 38.650' west longitude. Elevation 3140 m. (10300 feet).

SITE #11: 22 August 1995. Utah, Utah County. Uinta National Forest. American Fork Canyon, vicinity of Box Elder Peak and trail junction #044 & #045. GPS reading: 40° 29.246' north latitude; 111° 40.968' west longitude. Elevation 2800 m. (9200 feet).

METHODS

COLLECTION, CURATION, IDENTIFICATION AND DEPOSITION OF LICHEN SPECIMENS:

Because lichen distribution is directly influenced by substrate, moisture and sunlight, all available substrates and habitats at each reference site were carefully examined. Small amounts of each lichen species were either removed directly from the substrate, or depending on the species, with a small piece of the substrate (bark, wood, soil, or rock).

All specimens were placed in carefully labeled paper sacks and taken back to the BYU Herbarium of Nonvascular Cryptogams, where they were curated, identified, placed in permanent herbarium packets, and labeled with the current epithets and authors' names as well as detailed information about the collection site, habitat, and substrate. Herbarium numbers (BRY C-) were also assigned.

Species were identified using standard lichen keys and taxonomic treatises. Standard chemical spot tests and, where necessary, thin-layer chromatography techniques were used to finalize species identifications.

One set of specimens collected from each reference site will be permanently housed at the BYU Herbarium of Nonvascular Cryptogams in Provo, Utah. A second set of voucher specimens will be sent to any herbarium designated by the U.S. Forest Service.

COLLECTION OF SENSITIVE INDICATOR SPECIES FOR ELEMENTAL ANALYSES:

After careful consideration of species abundance, available substrates, growth form, documented/suspected pollution sensitivity and general distribution patterns, one to several pollution sensitive indicator species were collected, returned to the Elemental Analysis Laboratory at BYU and elemental analyses were performed.

At each reference site sufficient material of at least one sensitive, indicator species was collected for laboratory analysis (3-6 grams dry weight). All lichen material collected for elemental analyses was placed in Hubco cloth bags (to avoid contamination) and transported back to the BYU Herbarium of Nonvascular Cryptogams. Excess material is permanently stored in Hubco cloth bags in the elemental analysis collection at the BYU Herbarium for Nonvascular Cryptogams. This material is available for additional testing upon request.

DETERMINATION OF ELEMENTAL CONCENTRATIONS IN LICHEN TISSUES:

In the laboratory, surface debris and dust were removed from all samples. Clean, two gram samples of one indicator species from each reference site were delivered to the Elemental Analysis Laboratory at Brigham Young University.

Samples were prepared for PIXE analysis using the methods of Duflou et al. (1987). Lichen samples were placed in Teflon containers with a teflon coated steel ball, cooled to a liquid nitrogen temperature, powdered by brittle fracture using a Braun Mikro-Dismer tor II, and then dried in an Imperial IV Microprocessor Oven for 14 hours at 80°C. Subsample ighing 150 mg were

then weighed in to teflon containers and spiked with 1 ml of a 360 ppm yttrium solution. The samples were then oven dried again for 14 hours ant 80°C. Samples were then homogenized again using the micro-dismemberator. Approximately 1 mg of the powdered lichen was then carefully weighed onto a thin polycarbonate film in an area of 0.5 cm^2. A 1.5% solution of polystyrene in toluene was used to secure the sample to the film.

Samples were analyzed using a 2 MV Van de Graaff accelerator with a 2.28 MeV proton beam which passed through a 1.1 mg/cm^2 pyrolytic graphite diffuser foil. The proton beam was collimated to irradiate an area of 0.38 cm^2 on the sample. Typically, 10-100 nA proton beam currents were used. X-rays were detected using a Tracor x-ray spectrometer, model TX-3/48-206, with a 10mm^2 by 3 mm thick Si(Li) detector positioned at 90° to the proton beam. Samples were analyzed twice using different X-ray absorbers between the samples and the detector. One was a 49 mg/cm^2 Mylar absorber with a 0.27 mm^2 pinhole (2.8% of detector area). The Mylar was backed with 8.5 mg/cm^2 beryllium foil. A 98 mg/cm^2 Mylar absorber was also used.

To insure adequate quality control, samples of NIST SRM 1571, orchard leaves, and other standards were also prepared and analyzed using the same procedures.

RESULTS, OBSERVATIONS AND RECOMMENDATIONS

LICHEN MATERIAL COLLECTED FOR ELEMENTAL ANALYSES:

A total of 22 samples consisting of 4 species in 3 genera from two general substrates (bark and rock) were collected for elemental analyses. Proton Induced X-ray Emission (PIXE) techniques were used to analyze all samples. Below is a list of all of the elemental analysis samples by sample number, species, substrate and collection site (the first number represents the storage drawer and the second number represents the specimen bag number). All samples are stored in Hubco cloth bags in the Elemental Analysis Collection at the Herbarium of Non-vascular Cryptogams at Brigham Young University, Provo, Utah.

Sample#	Taxa	Substrate	Reference site
41-404	Rhizoplaca peltata	rock	2
41-405	Rhizoplaca peltata	rock	2
41-406	Xanthoria polycarpa	*Abies concolor*	2
41-407	Xanthoria polycarpa	*Acer* sp.	2
42-408	Xanthoria polycarpa	*Acer* sp.	3
42-409	Rhizoplaca peltata	rock	4
42-410	Rhizoplaca peltata	rock	4
42-411	Rhizoplaca peltata	rock	4
42-412	Xanthoria polycarpa	*Abies concolor*	4
42-413	Xanthoria polycarpa	*Quercus gambelii*	5
42-414	Lecanora sp.	granite	5
42-415	Rhizoplaca melanophthalma	rock	6
42-416	Xanthoria polycarpa	*Acer* sp.	6
42-417	Rhizoplaca melanophthalma	rock	7
42-418	Xanthoria polycarpa	*Abies concolor*	7
43-424	Xanthoria polycarpa	*Acer* sp.	9
43-425	Xanthoria polycarpa	*Quercus gambelii*	9
43-426	Rhizoplaca melanophthalma	rock	8
43-427	Rhizoplaca melanophthalma	rock	10
43-428	Rhizoplaca melanophthalma	rock	11
43-429	Xanthoria polycarpa	bark	11
45-444	Xanthoria polycarpa	*Quercus gambelii*	1

POLLUTION SENSITIVE INDICATOR SPECIES BY REFERENCE SITE:

vicinity of Box Elder Peak:

Candelariella vitellina (intermediately sensitive to sulfur dioxide)
Collema fuscovirens (sensitive to intermediately sensitive to ozone)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Xanthoria candelaria (sensitive to ozone; intermediately sensitive to sulfur dioxide)

near head of Brunnell's Canyon:

Caloplaca cerina (sensitive to intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Physcia dubia (sensitive to intermediately sensitive to sulfur dioxide)

vicinity of Gardner Creek:

Buellia punctata (intermediately sensitive to sulfur dioxide)
Collema tenax (sensitive to intermediately sensitive to ozone)
Melanelia subolivacea (intermediately sensitive to ozone)
Physcia stellaris (intermediately sensitive to sulfur dioxide)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Xanthoria candelaria (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Xanthoria fallax (intermediately sensitive to sulfur dioxide; sensitive to NO_x/PAN)
Xanthoria polycarpa (intermediately sensitive to sulfur dioxide)

vicinity of Hobble Creek Canyon-Camel Pass:

Buellia punctata (intermediately sensitive to sulfur dioxide)
Candelariella vitellina (intermediately sensitive to sulfur dioxide)
Collema coccophorum (sensitive to intermediately sensitive to ozone)
Physcia aipolia (intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Xanthoria polycarpa (intermediately sensitive to sulfur dioxide)

1 km north-west of North Fork Battle Creek Canyon:

Physcia dubia (sensitive to intermediately sensitive to flouride)
Xanthoria fallax (intermediately sensitive to sulfur dioxide; sensitive to NO_x/PAN)
Xanthoria polycarpa (intermediately sensitive to sulfur dioxide)

vicinity of Rock Canyon:

Caloplaca holocarpa (intermediately sensitive to sulfur dioxide)
Collema coccophorum (sensitive to intermediately sensitive to ozone)
Collema flaccidum (sensitive to intermediately sensitive to ozone)
Collema polycarpon (sensitive to intermediately sensitive to ozone)
Peltigera canina (sensitive to ozone)
Phaeophyscia orbicularis (sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Physcia tenella (intermediately sensitive to sulfur dioxide)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Xanthoria candelaria (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Xanthoria fallax (intermediately sensitive to sulfur dioxide; sensitive to NO_x/PAN)

vicinity of Silver Lake:
Xanthoria polycarpa (intermediately sensitive to sulfur dioxide)

vicinity of Sterling Hollow:
Melanelia subolivacea (intermediately sensitive to ozone)
Physcia aipolia (intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Xanthoria fallax (intermediately sensitive to sulfur dioxide; sensitive to NO_x/PAN)

vicinity of Timpanogos Basin:
Buellia punctata (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)

Timpanogos Cave National Monument:
Buellia punctata (intermediately sensitive to sulfur dioxide)
Caloplaca cerina (sensitive to intermediately sensitive to sulfur dioxide)
Lecanora saligna (intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (intermediately sensitive to ozone)
Peltigera canina (sensitive to ozone)
Phaeophyscia orbicularis (sensitive ozone; intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia adscendens (intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Physcia tenella (intermediately sensitive to sulfur dioxide)
Physconia detersa (intermediately sensitive to sulfur dioxide)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)

vicinity of Tinny campground:
Buellia punctata (intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (intermediately sensitive to ozone)
Peltigera canina (sensitive to ozone)
Physcia adscendens (intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Physcia stellaris (intermediately sensitive to sulfur dioxide)
Rhizoplaca chrysoleuca (sensitive to sulfur dioxide; sensitive to NO_x/PAN)
Xanthoria polycarpa (intermediately sensitive to sulfur dioxide)

CHECKLIST OF LICHEN SPECIES FROM SELECTED SITES IN THE UINTA NATIONAL FOREST, UTAH

Acarospora americana Magnusson
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Gardner Creek
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29878

Acarospora boulderensis Magnusson
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21815

Acarospora bullata Anzi
Growth form: crustose
Substrate: sandstone
Site(s): vicinity of Sterling Hollow
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29863

Acarospora cervina var. glaucocarpa (Wahlenb. *in* Ach.) Körber
Growth form: crustose
Substrate: limestone
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31194

Acarospora coloradiana Magnusson
Growth form: crustose
Substrate: rock
Site(s): vicinity of Timpanogos Basin
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29472

Acarospora fuscata (Nyl.) Arnold
Growth form: crustose
Substrate: sandstone, limestone
Site(s): vicinity of Sterling Hollow, vicinity of Tinny campground, Timpanogos Cave National Monument
Relative abundance: occasional to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29818, BRY C-29860, BRY C-29872

Acarospora glaucocarpa (Ach.) Körber
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21883

Acarospora schleicheri (Ach.) Massal.
Growth form: crustose
Substrate: rock
Site(s): vicinity of Hobble Creek Canyon at Camel Pass
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29996

Acarospora smaragdula (Wahlenb. *in* Ach.) Massal.
Growth form: crustose
Substrate: rock, lignum
Site(s): vicinity of Gardner Creek, vicinity of Hobble Creek Canyon at Camel Pass, near head of Brunnell's Canyon, 1 km north-west of North Fork Battle Creek Canyon
Relative abundance: occasional to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29429, BRY C-29443, BRY C-29452, BRY C-29904, BRY C-29918, BRY C-29988, BRY C-29989

Acarospora strigata (Nyl.) Jatta.
Growth form: crustose
Substrate: limestone, sandstone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Gardner Creek, vicinity of Hobble Creek Canyon at Camel Pass
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21884, BRY C-29867, BRY C-29880, BRY C-29888, BRY C-29993

Agrestia hispida (Meresch,.) Hale & Culb.
Growth form: fruticose
Substrate: vagrant on soil
Site(s): vicinity of Gardner Creek
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29876

Aspicilia caesiocinerea (Nyl. *ex* Malbr.)
Growth form: crustose
Substrate: granite, quartzite, limestone
Site(s): vicinity of Silver Lake, vicinity of Tinny campground, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Box Elder Peak, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: occasional to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29463, BRY C-29447, BRY C-29471, BRY C-29520, BRY C-29784, BRY C-29946, BRY C-29948, BRY C-29967

Aspicilia calcarea (L.) Mudd.
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Tinny campground, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21885, BRY C-21886, BRY C-21887, BRY C-29401, BRY C-29493, BRY C-29983, BRY C-29987

Aspicilia cinerea (L.) Körber
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-22391, BRY C-29983

Aspicilia desertorum (Krempelh.) Mereschk.
Growth form: crustose
Substrate: limestone, sandstone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21888, BRY C-21889, BRY C-29857

Bellemerea alpina (Sommer.) Clauz. & Roux
Growth form: crustose
Substrate: rock
Site(s): near head of Brunnell's Canyon, vicinity of Timpanogos Basin
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of spoecimens: BYU Herbarium: BRY C-29416, BRY C-29478

Buellia punctata (Hoffm.) Massal.
Growth form: crustose
Substrate: limestone, *Juniperus scopulorum*, lignum, *Acer grandidentatum*
Site(s): vicinity of Gardner Creek, vicinity of Tinny campground, vicinity of Timpanogos Basin, vicinity of Hobble Creek Canyon at Camel Pass, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments:
Deposition of specimens: BYU Herbarium: BRY C-29495, BRY C-29780, BRY C-29816, BRY C-29894, BRY C-29897

Buellia turgescens Tuck.
Growth form: crustose
Substrate: limestone
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31196

Caloplaca arizonica Magnusson
Growth form: crustose
Substrate: lignum, *Juniperus scopulorum*
Site(s): vicinity of Gardner Creek, vicinity of Tinny campground
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29815, BRY C-29915

Caloplaca cerina (Ehrh. *ex* Hedwig) Th. Fr.
Growth form: crustose
Substrate: rock, *Ribes inerme*
Site(s): near head of Brunnell's Canyon, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29407, BRY C-29534a

Caloplaca citrina (Hoffm.) Th. Fr.
Growth form: crustose
Substrate: limestone, sandstone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, near head of Brunnell's Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21890, BRY C-29407, BRY C-29854a

Caloplaca decipiens (Arnold) Blomb. & Forss.
Growth form: crustose
Substrate: rock
Site(s): vicinity of Gardner Creek
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29909

Caloplaca epithallina Lynge
Growth form: crustose (absent)
Substrate: growing over other lichens
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31197

Caloplaca fraudans (Th. Fr.) H. Olivier
Growth form: crustose
Substrate: sandstone
Site(s): vicinity of Sterling Hollow, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Timpanogos Basin
Relative abundance: occasional to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29445, BRY C-29482, BRY C-29856a

Caloplaca holocarpa (Hoffm. *ex* Ach.) M. Wade
Growth form: crustose
Substrate: *Populus angustifolia*
Site(s): vicinity of Rock Canyon
Relative abundance: common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21891

Caloplaca tominii Savicz
Growth form: crustose
Substrate: soil
Site(s): vicinity of Gardner Creek, vicinity of Hobble Creek Canyon at Camel Pass
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29892, BRY C-29975

Caloplaca trachyphylla (Tuck.) Zahlbr.
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21892, BRY C-29976

Candelariella aurella (Hoffm.) Zahlbr.
Growth form: crustose
Substrate: sandstone, limestone
Site(s): vicinity of Sterling Hollow, vicinity of Gardner Creek, near head of Brunnell's Canyon, vicinity of Box Elder Peak, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: occasional to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29419, BRY C-29481, BRY C-29511, BRY C-29854, BRY C-29881

Candelariella deflexa (Nyl.) Zahlbr.
Growth form: crustose
Substrate: *Populus angustifolia, Quercus gambelii, Artemisia tridentata, Juniperus osteosperma*
Site(s): vicinity of Rock Canyon, vicinity of Gardner Creek
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21893, BRY C-21894, BRY C-29911, BRY C-29913

Candelariella rosulans (Müll. Arg.) Zahlbr.
Growth form: crustose
Substrate: quartzite, granite, limestone
Site(s): vicinity of Rock Canyon, vicinity of Gardner Creek, vicinity of Silver Lake, near head of Brunnell's Canyon, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: rare to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21895, BRY C-29423, BRY C-29446, BRY C-29470, BRY C-29903, BRY C-29933

Candelariella spraguei (Tuck.) Zahlbr.
Growth form: crustose
Substrate: lignum
Site(s): vicinity of Box Elder Peak
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29524

Candelariella vitellina (Hoffm.) Müll
Growth form: crustose
Substrate: rock, moss
Site(s): vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29530, BRY C-29982

Candelariella xanthostigma (Ach.) Lettau
Growth form: crustose
Substrate: *Pseudotsuga menziesii*, lignum
Site(s): near head of Brunnell's Canyon, vicinity of Tinny campground
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29421, BRY C-29804, BRY C-29806

Catapyrenium cinereum (Pers.) Körber
Growth form: squamulose
Substrate: soil
Site(s): vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29916, BRY C-29998

Catapyrenium compactum (Mass.) R. Sant.
Growth form: squamulose
Substrate: limestone
Site(s): near head of Brunnell's Canyon, 1 km north-west of North Battle Creek Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29426, BRY C-29466

Catapyrenium daedaleum (Kremp.) Stein
Growth form: squamulose
Substrate: soil
Site(s): vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29887

Catapyrenium granulosum (B. de Lesd.) Thomson
Growth form: squamulose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21896

Catapyrenium squamulosum Ach.) Breuss
Growth form: squamulose
Substrate: soil over limestone, soil
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Timpanogos Basin, vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21897, BRY C-29499, BRY C-29907, BRY C-29985, BRY C-29997

Catillaria chalybeia (Borrer) Massal.
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Gardner Creek, vicinity of Tinny campground
Relative abundance: frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29785, BRY C-29799, BRY C-29898

Cecidonia umbonella (Nyl.) Triebel & Rambold
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: Name changed from *Lecidea umbonella* Nyl.
Deposition of specimens: BYU Herbarium: BRY C-29893

Collema coccophorum Tuck.
Growth form: foliose
Substrate: limestone, soil
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21898, BRY C-29985a

Collema flaccidum (Ach.) Ach.
Growth form: foliose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare to common
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21899, BRY C-21900

Collema fuscovirens (With.) Laundon
Growth form: foliose
Substrate: limestone
Site(s): vicinity of Box Elder Peak
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29521

Collema polycarpon Hoffm.
Growth form: foliose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21901

Collema tenax (Sw.) Ach.
Growth form: foliose
Substrate: soil
Site(s): vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29877a

Dermatocarpon intestiniforme (Körber) Hasse
Growth form: foliose (umbilicate)
Substrate: quartzite, granite, limestone
Site(s): vicinity of Rock Canyon, vicinity of Silver Lake, vicinity of Box Elder Peak
Relative abundance: rare to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21902, BRY C-22390, BRY C-29509, BRY C-29529, BRY C-29952

Dermatocarpon miniatum (L.) Mann.
Growth form: foliose (umbilicate)
Substrate: limestone, sandstone, granite
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Silver Lake, Timpanogos Cave National Monument
Relative abundance: common to abundant
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-2903, BRY C-21904, BRY C-29868, BRY C-29942

Dermatocarpon reticulatum Magnusson
Growth form: foliose (umbilicate)
Substrate: limestone, granite, rock
Site(s): vicinity of Rock Canyon, vicinity of Silver Lake, vicinity of Hobble Creek Canyon at Camel Pass, near head of Brunnell's Canyon, vicinity of Tinny campground, 1 km northwest of North Fork Battle Creek Canyon, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: occasional to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21905, BRY C-29413, BRY C-29418, BRY C-29450, BRY C-29537, BRY C-29788, BRY C-29938, BRY C-29951, BRY C-29991

Dimelaena oreina (Ach.) Norman
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21906

Dimelaena thysanota (Tuck.) Hale & Culb.
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21677

Diplotomma alboatrum (Hoffm.) Flotow
Growth form:
Substrate: limestone
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21907

Endocarpon pulvinatum Th. Fr.
Growth form: crustose
Substrate: rock
Site(s): near head of Brunnell's Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29415

Fulgensia fulgens (Swartz) Elenkin
Growth form: crustose with lobate margins
Substrate: soil over limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21908

Glypholecia scabra (Pers.) Müll
Growth form: foliose (umbilicate)
Substrate: limestone
Site(s): vicinity of Gardner Creek
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29896

Gonohymenia nigritella (Lettau) Henseen
Growth form: foliose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21909

Hyperphyscia adglutinata (Flörke) H. Mayrh. & Poelt
Growth form: foliose
Substrate: *Quercus gambelii*
Site(s): vicinity of Rock Canyon
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21940

Hyperphyscia syncolla (Tuck. *ex* Nyl.) Kalb
Growth form: foliose
Substrate: bark
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31198

Lecania erysibe (Ach.) Mudd
Growth form: crustose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Polllution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31199

Lecanora argopholis (Ach.) Ach.
Growth form: crustose
Substrate: granite
Site(s): vicinity of Silver Lake
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29929

Lecanora cenisia Ach.
Growth form: crustose
Substrate: limestone
Site(s): near head of Brunnell's Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29427

Lecanora christoi W. Weber
Growth form: crustose with effigurate margins
Substrate: limestone
Site(s): vicinity of Gardner Creek, vicinity of Hobble Creek Canyon at Camel Pass, Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29920, BRY C-29922, BRY C-29974

Lecanora crenulata Hook.
Growth form: crustose (absent)
Substrate: rock
Site(s): vicinity of Gardner Creek, Timpanogos Cave National Monument
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29901

Lecanora dispersa (Pers.) Sommerf.
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon, vicinity of Tinny campground, vicinity of Box Elder Peak
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21910, BRY C-29402, BRY C-29539

Lecanora garovaglii (Körber) Zahlbr.
Growth form: crustose with effigurate margins
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31200

Lecanora hageni (Ach.) Ach.
Growth form: crustose
Substrate: *Populus angustifolia, Quercus gamebelii, Acer grandidentatum, Ribes inerme*
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21911, BRY C-21912, BRY C-29442, BRY C-29536, BRY C-29782

Lecanora muralis (Schreber) Rabenh.
Growth form: crustose with effigurate margins
Substrate: lignum, sandstone, granite
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Silver Lake, 1 km north-west of North Fork Battle Creek Canyon, Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21913, BRY C-29453, BRY C-29853, BRY C-29968

Lecanora novomexicana (B. De Lesd.) Zahlbr.
Growth form: crustose
Substrate: rock
Site(s): near head of Brunnell's Canyon, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Timpanogos Basin
Relative abundance: occasional to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29437, BRY C-29457, BRY C-29485

Lecanora piniperda Körber
Growth form: crustose (absent)
Substrate: bark
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31201

Lecanora polytropa (Hoffm.) Rabenh.
Growth form: crustose
Substrate: rock
Site(s): near head of Brunnell's Canyon, vicinity of Timpanogos Basin
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29408, BRY C-29467

Lecanora rupicola (L.) Zahlbr.
Growth form: crustose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31202

Lecanora saligna (Schrader) Zahlbr.
Growth form: crustose
Substrate: bark, lignum
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31203

Lecanora thallophila Magnusson
Growth form: crustose (absent)
Substrate: growing over thalli of *Dermatocarpon intestiniforme*
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21914

Lecanora varia (Hoffm.) Ach.
Growth form: crustose (absent)
Substrate: bark
Site(s): Timpanogos Cave National Monument
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31204

Lecidea atrobrunnea (Ramond *in* Lam. & DC.) Schaerer
Growth form: crustose
Substrate: granite, limestone
Site(s): vicinity of Silver Lake, vicinity of Hobble Creek Canyon at Camel Pass, near head of Brunnell's Canyon, vicinity of Box Elder Peak, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: occasional to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29434, BRY C-29469, BRY C-29484, BRY C-29527, BRY C-29944, BRY C-29949, BRY C-29971, BRY C-29981

Lecidea auriculata Th. Fr.
Growth form: crustose
Substrate: sandstone
Site(s): vicinity of Sterling Hallow, 1 km north-west of North Fork Battle Creek Canyon
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29465, BRY C-29852

Lecidea hypocrita Massal.
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Silver Lake
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29969

Lecidea leucothallina Arnold
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21915

Lecidea tessellata Flörke
Growth form: crustose
Substrate: rock
Site(s): vicinity of Gardner Creek, Timpanogos Cave National Monument
Relative abundance: frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29889

Lecidea turgidula Fr.
Growth form: crustose
Substrate: *Populus angustifolia*
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21916

Lecidella anomaloides (Massal.) Hertel & Kilias
Growth form: crustose
Substrate: rock
Site(s): 1 km north-west of North Fork Battle Creek Canyon
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29448, BRY C-29449

Lecidella carpathica Körber
Growth form: crustose
Substrate: rock
Site(s): vicinity of Hobble Creek Canyon at Camel Pass, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29990

Lecidella euphorea (Flörke) Hertel
Growth form: crustose
Substrate: *Pseudotsuga menziesii, Amelanchier alnifolia*, lignum
Site(s): vicinity of Tinny campground, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29404, BRY C-29525, BRY C-29793

Lecidella stigmatea (Ach.) Hertel & Leuck.
Growth form: crustose
Substrate: limestone, sandstone, granite
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicnity of Silver Lake, vicinity of Hobble Creek Canyon at Camel Pass, near head of Brunnell's Canyon, 1 km north-west of North Fork Battle Creek Canyon, Timpanogos Cave National Monument
Relative abundance: rare to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21939, BRY C-29409, BRY C-29439, BRY C-29461, BRY C-29866, BRY C-29927, BRY C-29994

Lepraria incana (L.) Ach.
Growth form: crustose (leprose)
Substrate: moss, rock
Site(s): vicinity of Rock Canyon, near head of Brunnell's Canyon
Relative abundance: rare to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21917, BRY C-29411

Leproloma vouaxii
Growth form: crustose (leprose)
Substrate: moss over quartzite
Site(s): vicinity of Silver Lake
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29963

Leptogium cyanescens (Rabenh.) Körber
Growth form: foliose
Substrate: moss over rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31205

Lobothallia alphoplaca (Wahlenb.) Hafelner
Growth form: crustose
Substrate: limestone, granite, quartzite
Site(s): vicinity of Gardner Creek, vicinity of Silver Lake, Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29921, BRY C-29950, BRY C-29961

Lobothallia praeradiosa (Nyl.) Hafellner
Growth form: crustose with effigurate margins
Substrate: limestone
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31195

Megaspora verrucosa (Ach.) Hafellner & Wirth
Growth form: crustose
Substrate: soil, moss over quartzite, *Juniperus scopulorum*
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument, vicinity of Tinny Campground
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29813, BRY C-21918, BRY C-21919

Melanelia disjuncta (Erichsen) Essl.
Growth form: foliose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31206

Melanelia elegantula (Zahlbr.) Essl.
Growth form: foliose
Substrate: *Pseudotsuga menziesii*, *Quercus gambelii*, *Juniperus scopulorum*, *Acer grandidentatum*, moss, *Symphoricarpos oreophilus*, *Ribes inerme*, *Cercocarpus intricatus*
Site(s): vicinity of Tinny campground, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Box Elder Peak, vicinity of Sterling Hollow
Relative abundance: occasional to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29441, BRY C-29459, BRY C-29508, BRY C-29531, BRY C-29533, BRY C-29535, BRY C-29540, BRY C-29794, BRY C-29802, BRY C-29811, BRY C-29812, BRY C-29870

Melanelia subolivacea (Nyl. *in* Hasse) Essl.
Growth form: foliose
Substrate: *Quercus gambelii*, *Acer grandidentatum*, *Cercocarpus ledifolius*, *Cercocarpus intricatus*
Site(s): vicinity of Sterling Hollow, vicinity of Gardner Creek, vicinity of Tinny campground, Timpanogos Cave National Monument
Relative abundance: occasional
Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29808, BRY C-29823, BRY C-29851, BRY C-29874, BRY C-29883

Neofuscelia loxodes (Nyl.) Essl.
Growth form: foliose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31207

Peltigera canina (L.) Willd.
Growth form: foliose
Substrate: moss over rock, moss over lignum, moss over soil, soil
Site(s): vicinity of Rock Canyon, near head of Brunnell's Canyon, vicinity of Tinny campground, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21920, BRY C-29403, BRY C-29406, BRY C-29412, BRY C-29476, BRY C-29500

Peltula bolanderi (Tuck.) Wetm.
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Gardner Creek
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29882

Phaeophyscia ciliata (Hoffm.) Moberg.
Growth form: foliose
Substrate: *Pseudotsuga menziesii*
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21921

Phaeophyscia endococcina (Körber) Moberg
Growth form: foliose
Substrate: quartzite
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21922

Phaeophyscia hispidula (Ach.) Moberg
Growth form: foliose
Substrate: moss over rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31208

Phaeophyscia nigricans (Flörke) Moberg
Growth form: foliose
Substrate: *Populus angustifolia*
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21923

Phaeophyscia orbicularis (Necker) Moberg
Growth form: foliose
Substrate: *Populus angustifolia*, *Acer grandidentatum*, limestone, quartzite, moss over quartzite, moss over limestone, moss, lignum
Site(s): vicinity of Rock Canyon, vicinity of Tinny campground, Timpanogos Cave National Monument
Relative abundance: rare to abundant
Pollution sensitivity: sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21924, BRY C-21925, BRY C-21926, BRY C-21927, BRY C-21928, BRY C-21929, BRY C-21930, BRY C-21931, BRY C-21932, BRY C-29805

Physcia adscendens (Fr.) H. Olivier
Growth form: foliose
Substrate: *Abies concolor*
Site(s): vicinity of Tinny campground, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide; sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29797

Physcia aipolia (Ehrh. *ex* Humb.) Fürnr.
Growth form: foliose
Substrate: *Quercus gambelii, Acer grandidentatum*
Site(s): vicinity of Sterling Hollow, vicinity of Hobble Creek Canyon at Camel Pass
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide; sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29850, BRY C-29859, BRY C-29980, BRY C-29986

Physcia caesia (Hoffm.) Fürnr.
Growth form: foliose
Substrate: moss over rock, quartzite, sandstone, lignum
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Tinny campground, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21933, BRY C-21934, BRY C-29406a, BRY C-29487, BRY C-29855

Physcia dimidiata (Arnold) Nyl.
Growth form: foliose
Substrate: *Quercus gambelii*
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21935

Physcia dubia (Hoffm.) Lettau.
Growth form: foliose
Substrate: quartzite, moss, sandstone, *Acer grandidentatum*, *Pseudotsuga menziesii*, limestone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Hobble Creek Canyon at Camel Pass, near head of Brunnell's Canyon, vicinity of Tinny campground, 1 km north-west of North Fork Battle Creek Canyon, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: occasional to common
Pollution sensitivity: sensitive to intermediately sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21936, BRY C-21937, BRY C-21938, BRY C-29422, BRY C-29424, BRY C-29436, BRY C-29438, BRY C-29460, BRY C-29462, BRY C-29505, BRY C-29781, BRY C-29787, BRY C-29865, BRY C-29875, BRY C-29992

Physcia phaea (Tuck.) Thomson
Growth form: foliose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31209

Physcia stellaris (L.) Nyl.
Growth form: foliose
Substrate: *Quercus gambelli*, *Pseudotsuga menziesii*, *Cercocarpus ledifolius*
Site(s): vicinity of Gardner Creek, vicinity of Tinny campground
Relative abundance: common to locally abundant
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29795, BRY C-29885, BRY C-29807

Physcia tenella (Scop.) DC.*in* Lam. & DC.
Growth form: foliose
Substrate: limestone
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21939

Physciella chloantha (Ach.) Essl.
Growth form: foliose
Substrate: bark
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31210

Physciella melanchra (Hue) Essl.
Growth form: foliose
Substrate: bark
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31211

Physconia detersa (Nyl.) Poelt.
Growth form: foliose
Substrate: moss over rock
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21941

Physconia grisea (Lam.) Poelt.
Growth form: foliose
Substrate: *Quercus gambelii*, moss
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21942, BRY C-21943, BRY C-21944

Physconia muscigena (Ach.) Poelt.
Growth form: foliose
Substrate: limestone, soil, moss over rock
Site(s): vicinity of Rock Canyon
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21946, BRY C-21947, BRY C-21948, BRY C-21949

Polysporina simplex (Davies) Vezda
Growth form: crustose
Substrate: rock
Site(s): near head of Brunnell's Canyon, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29430

Psora globifera (Ach.) Massal.
Growth form: squamulose
Substrate: soil over rock
Site(s): 1 km north-west of North Fork Battle Creek Canyon
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29454

Psora himalayana (Church. Bab.) Timdal
Growth form: squamulose
Substrate: moss over rock
Site(s): near head of Brunnell's Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29435

Psora luridella (Tuck.) Fink
Growth form: squamulose
Substrate: soil over rock
Site(s): 1 km north-west of North Fork Battle Creek Canyon
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29455

Psora rubiformis (Ach.) Hook.
Growth form: squamulose
Substrate: moss over rock, rock, soil
Site(s): near head of Brunnell's Canyon, vicinity of Box Elder Peak
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29417, BRY C-29504

Psora tuckermanii R. Anderson *ex* Timdal
Growth form: squamulose
Substrate: soil over limestone, soil over sandstone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Gardner Creek
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21950, BRY C-29871, BRY C-29908

Rhizocarpon disporum (Naeg. *ex* Hepp) Müll.
Growth form: crustose
Substrate: granite, quartzite
Site(s): vicinity of Silver Lake, Timpanogos Cave National Monument
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29935, BRY C-29939

Rhizocarpon geminatum Körber
Growth form: crustose
Substrate: quartzite
Site(s): vicinity of Rock Canyon
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21951, BRY C-21952

Rhizocarpon riparium Räsänen
Growth form: crustose
Substrate: granite
Site(s): vicinity of Silver Lake
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29943

Rhizoplaca chrysoleuca (Sm.) Zopf
Growth form: foliose (umbilicate)
Substrate: limestone
Site(s): vicinity of Tinny campground
Relative abundance: rare
Pollution sensitivity: sensitive to sulfur dioxide; sensitive to NO_X/PAN (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29820

Rhizoplaca melanophthalma (DC. *in* Lam. & DC.) Leuck. & Poelt
Growth form: foliose (umbilicate)
Substrate: limestone, quartzite, sandstone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Gardner Creek, vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21953, BRY C-21954, BRY C-29489, BRY C-29864a, BRY C-29895, BRY C-29977

Rhizoplaca peltata (Ramond) Leuck. & Poelt
Growth form: foliose (umbilicate)
Substrate: quartzite, sandstone, limestone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Tinny campground, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21955, BRY C-29819, BRY C-29864

Rinodina archaea (Ach.) Arnold
Growth form: crustose
Substrate: lignum
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31212

Rinodina bischoffii (Hepp.) Massal
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21956

Rinodina pyrina (Ach.) Arnold
Growth form: crustose
Substrate: *Acer grandidentatum*
Site(s): vicinity of Rock Canyon, Timpanogos Cave National Monument
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21957, BRY C-21958, BRY C-21959

Rinodina turfacea (Wahlenb.) Körber
Growth form: crustose
Substrate: *Pseudotsuga menziesii*
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-22392

Sarcogyne privigna (Ach.) Massal.
Growth form: crustose
Substrate: rock
Site(s): vicinity of Gardner Creek
Relative abundance: frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29919

Staurothele areolata (Ach.) Lett.
Growth form: crustose
Substrate: rock
Site(s): near head of Brunnell's Canyon, Timpanogos Cave National Monument
Relative abundance: occasional
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29410

Staurothele catalepta (Ach.) Blomb. & Forss.
Growth form: crustose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31213

Staurothele drummondii (Tuck.) Tuck.
Growth form: crustose (with somewhat effigurate margins)
Substrate: limestone
Site(s): vicinity of Hobble Creek Canyon at Camel Pass, near head of Brunnell's Canyon, vicinity of Tinny campground, vicinity of Box Elder Peak, Timpanogos Cave National Monument
Relative abundance: frequent to abundant
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29414, BRY C-29432, BRY C-29526, BRY C-29786, BRY C-29821, BRY C-29972

Staurothele effigurata Thomson
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Box Elder Peak, vicinity of Timpanogos Basin
Relative abundance: rare to frequent
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29492, BRY C-29510, BRY C-29522

Staurothele fuscocuprea (Nyl.) Zsch.
Growth form: crustose
Substrate: sandstone
Site(s): vicinity of Sterling Hollow
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29862

Staurothele orispruinosa Thomson
Growth form: crustose
Substrate: rock
Site(s): vicinity of Box Elder Peak
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29518

Staurothele rupifraga (Massal.) Arnold
Growth form: crustose
Substrate: rock
Site(s): vicinity of Gardner Creek, Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29899

Toninia caeruleonigricans (Lightf.) Th. Fr.
Growth form: crustose
Substrate: soil, moss over limestone
Site(s): vicinity of Rock Canyon, vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21960, BRY C-21961, BRY C-29890

Toninia candida (Weber) Th. Fr.
Growth form: squamulose
Substrate: soil
Site(s): vicinity of Gardner Creek, vicinity of Tinny campground
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29810, BRY C-29905

Umbilicaria phaea Tuck.
Growth form: foliose (umbilicate)
Substrate: quartzite
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21962

Umbilicaria torrefacta (Lightf.) Schrader
Growth form: foliose (umbilicate)
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21963

Umbilicaria virginis Schaerer
Growth form: foliose (umbilicate)
Substrate: quartzite, limestone
Site(s): vicinity of Rock Canyon, vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Timpanogos Basin
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21965, BRY C-29490, BRY C-29979

Verrucaria dufourii DC.
Growth form: crustose
Substrate: rock
Site(s): vicinity of Gardner Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-29917

Verrucaria hydrela Ach.
Growth form: crustose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31214

Verrucaria muralis Ach.
Growth form: crustose
Substrate: limestone
Site(s): vicinity of Rock Canyon
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21966

Xanthoparmelia plittii (Gylnik *ex* D. Dietr.) Hale
Growth form: foliose
Substrate: moss over rock, quartzite
Site(s): vicinity of Rock Canyon
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21968

Xanthoria candelaria (L.) Th. Fr.
Growth form: minutely foliose
Substrate: *Populus angustifolia, Artemisia tridentata, Juniperus osteosperma, Symphoricarpos oreophilus, Ribes inerme*
Site(s): vicinity of Rock Canyon, vicinity of Gardner Creek, vicinity of Box Elder Peak
Relative abundance: rare to common
Pollution sensitivity: sensitive to ozone; intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21969, BRY C-29532, BRY C-29534, BRY C-29910, BRY C-29914

Xanthoria elegans (Link) Th. Fr.
Growth form: minutely fruticose
Substrate: quartzite, limestone, moss, sandstone
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Gardner Creek, near head of Brunnell's Canyon, vicinity of Tinny campground, vicinity of Box Elder Peak, vicinity of Timpanogos Basin, Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21970, BRY C-21971, BRY C-21972, BRY C-21973, BRY C-29420, BRY C-29486, BRY C-29512, BRY C-29783, BRY C-29856, BRY C-29879

Xanthoria fallax (Hepp *in* Arnold) Arnold
Growth form: foliose
Substrate: over moss, *Acer grandidentatum, Purshia mexicana, Quercus gambelii*
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Gardner Creek, 1 km north-west of North Fork Battle Creek Canyon, Timpanogos Cave National Monument
Relative abundance: common to abundant
Pollution sensitivity: intermediately sensitive to sulfur dioxide; sensitive to NO_x/PAN (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21974, BRY C-21975, BRY C-29440, BRY C-29873, BRY C-29900

Xanthoria polycarpa (Hoffm.) Rieber
Growth form: foliose
Substrate: *Populus angustifolia*, lignum, *Quercus gambelii*, *Acer grandidentatum*, *Abies concolor*, *Populus tremuloides*, *Pseudotsuga menziesii*, *Cercocarpus ledifolius*, *Cercocarpus intricatus*, *Amelanchier alnifolia*
Site(s): vicinity of Rock Canyon, vicinity of Sterling Hollow, vicinity of Gardner Creek, vicinity of Silver Lake, vicinity of Hobble Creek Canyon at Camel Pass, vicinity of Tinny campground, 1 km north-west of North Fork Battle Creek Canyon, Timpanogos Cave National Monument
Relative abundance: rare to abundant
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21976, BRY C-21977, BRY C-21979, BRY C-21981, BRY C-29400, BRY C-29405, BRY C-29458, BRY C-29791, BRY C-29796, BRY C-29801, BRY C-29809, BRY C-29824, BRY C-29849, BRY C-29858, BRY C-29884, BRY C-29970, BRY C-29978, BRY C-29999

Xanthoria sorediata (Vainio) Poelt
Growth form: foliose
Substrate: rock
Site(s): Timpanogos Cave National Monument
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31215

OBSERVATIONS AND CONCLUSIONS:

1. Lichen species collected at selected sites in the Uinta National Forest comprise a diverse and well developed flora. From our collections at 11 reference sites along the Wasatch Front we have identified a total of 155 species in 47 genera. All growth forms are represented; however the flora is heavily dominated by crustose species (60.3%, 91 species), followed by foliose species (31.1%, 47 species). Squamulose lichens make up 7.3% of the flora (11 species); while fruticose species comprise only 1.3% of the flora with 2 species. This growth form pattern is somewhat typical of core Rocky Mountain lichen floras which are characteristically dominated by crustose species (e.g. 48% in the Bridger Wilderness Area, and 50% in the High Uintas Wilderness Area; with foliose species representing only 28% and 29% of the lichen floras of those wilderness areas). The abundance of crustose species along the Wasatch Front (a growth form generally thought to be more tolerant of air pollution) suggests that other more sensitive growth forms (especially fruticose and foliose species) may have over time been reduced in numbers due to declining air quality.

2. Lichen specimens were collected from 5 basic substrates: rocks, lignum/bark, moss/detritus, soil and the thalli of other lichen species. A total of 96 species (63.6% of the flora) were collected from various rock substrates. Species on bark and lignum substrates were next in abundance, totaling 32 species (21.2% of the flora). Twelve species (7.9% of the flora) were collected from the soil while 9 species (6% of the flora) were collected from moss and detritus substrates. Finally, 2 species (1.3% of the flora) occurred as epiphytes on other lichen species. Intermountain Area lichen floras are typically dominated by saxicolous (rock) species. For example, 37% (67 species) of the lichen flora from the High Uintas Wilderness Area (northeastern Utah) are from rock substrates with only 23% (41 species) from corticolous (bark and lignum) substrates. The Bridger Wilderness Area, in western Wyoming, shows a similar pattern with 51% (76 species) reported from rock substrates and only 23% (35 species) from bark and lignum.

3. Total species diversity (155 species in 47 genera) suggests that the lichen communities along the Wasatch Front have been minimally impacted by air pollution. However, the relatively low number of sensitive indicator species at some of the reference sites {e.g. vicinity of Box Elder Peak (4 species), near head of Brunnell's Canyon (3 species), vicinity of North Fork of Battle Creek Canyon (3 species), vicinity of Silver Lake (1 species), and vicinity of Timpanogos Basin (4 species)}, along with the general over abundance of crustose species indicates there may be at least some localized air pollution impact. Another possible explanation for the general lack of sensitive indicator species at some of the reference sites may be related to substrate issues or some unusual combination of microclimatic factors.

4. Necrotic and/or bleached thalli (typical signs of air pollution-related impact) were generally absent. However, the large foliose species where this type of damage is most often observed are conspicuously missing along the Wasatch Front.

5. Baseline concentrations of potential pollutant elements were determined by analyzing the tissues of at least one sensitive indicator species from each reference site (Table 1). Thallus concentrations of several pollutants exceeded background levels (Figure 2). For example, six samples (from five different reference sites) of *Xanthoria polycarpa* (a foliose, corticolous lichen which is intermediately sensitive to sulfur dioxide) showed high levels of sulfur, ranging from .254% to .316% (Table 1.). It is generally agreed that thallus sulfur concentrations of .2% or higher indicate significant sulfur accumulation, and may interfere with sensitive metabolic activities such as photosynthesis, cellular respiration and nitrogen fixation. Five other samples (representing 4 additional reference sites) demonstrated moderately high thallus sulfur values, ranging from .165% to .194% (Table 1.). Several samples also had somewhat elevated lead levels, ranging from 67 ppm to 173 ppm (Table 1.). Technically these concentrations are in the lower half of the elevated concentration range (Figure 2.); however, they are generally higher than values reported for samples from other Intermountain Area locations (St. Clair and Newberry 1995). Across all reference sites thallus concentrations of arsenic (1.32 ppm to 9.89 ppm) exceeded background levels and certainly on the average exceeded values reported for most other Intermountain Area reference sites. Overall, nickel concentrations (2.24 ppm to 18.4 ppm) were also higher than values reported for most other locations in the Rocky Mountain Region; however, they are still within background levels (except for two samples, 11.9 ppm and 18.4 ppm). Finally, chromium concentrations are moderately high at all reference sites, ranging from 6.26 ppm to 22.3 ppm. This type of pollution accumulation pattern reflects the general proximity of all reference sites to the heavily populated and industrialized Wasatch Front.

RECOMMENDATIONS:

1. Usually, re-evaluation of pollutant concentrations in sensitive indicator species should be performed every 5 to 8 years. However, because thallus concentrations of several critical pollutants already exceed background levels, sensitive indicator species along the Wasatch Front should be reassessed every 2-3 years.

2. Re-evaluation of the lichen flora at existing reference sites is generally unnecessary, unless over time sensitive indicator species begin to show either increasing levels of pollutant elements or significant changes in relative abundance. At this point re-evaluation of the lichen communities at the eleven reference sites along the Wasatch Front does not appear to be necessary.

3. Meaningful baseline data are sometimes difficult to obtain in ar[illegible]th pre-existing air pollution impact. In some situations transplant studies have be[illegible]se to add critical baseline information about air pollution effects on sensitive indicator species. Therefore,

TABLE #1: Mean concentrations of potential pollutant elements in sensitive indicator species from air quality biomonitoring reference sites in the Uinta National Forest.

Species and Collection Site	Elements (ppm except where indicated									
	S%	Cl	K%	Ca%	Ti	V	Cr	Ni	Cu	Zn
Rhizoplaca peltata, Rock Canyon-mines, Sample #404	0.082	1630	0.217	7.29	378	13.7	6.57	3.62	11.2	52.6
Rhizoplaca peltata, Rock Canyon, Sample #405	0.09	1150	0.42	5.26	640	18.7	11.7	4.59	11.7	50.6
Xanthoria polycarpa, Rock Canyon-RC camp, Sample #406	0.185	1600	0.761	0.287	360	13.9	10.4	4.21	13.3	166
Xanthoria polycarpa, Rock Canyon-RC camp, Sample #407	0.194	1190	0.857	0.268	196	7.74	5.27	2.24	9.08	129
Xanthoria polycarpa, Gardner Canyon, Sample #408	0.268	1600	0.942	0.374	383	n.d.	9.36	3.47	12.7	97.6
Rhizoplaca peltata, American Fork Canyon, Sample #409	0.098	1230	0.43	7.34	400	18.3	8.7	3.79	15.1	59
Rhizoplaca peltata, American Fork Canyon, Sample #410	0.106	1400	0.281	8.52	435	12.5	11.3	4.18	17.3	71.1
Rhizoplaca peltata, American Fork Canyon, Sample #411	0.091	1520	0.284	5.38	462	14.5	10.4	4.15	17.4	59.5
Xanthoria polycarpa, American Fork Canyon, Sample #412	0.254	1920	1.06	0.472	431	16.7	12.7	4.69	18.6	214
Xanthoria polycarpa, Silver Lake Flat, Sample #413	0.291	2340	1.05	0.279	304	7.94	6.26	3.21	13.7	144
Lecanora sp., Silver Lake Flat, Sample #414	0.045	80	1.37	3.8	1930	58.7	21.4	18.4	9.79	67.6
Rhizoplaca melanophthalma, Hobble Crk., Sample #415	0.145	156	0.323	1.49	334	n.d.	7.79	3.19	12.3	60.4

TABLE #1: continued

Species and Collection Site	Elements (ppm except where indicated									
	S%	Cl	K%	Ca%	Ti	V	Cr	Ni	Cu	Zn
Xanthoria polycarpa, Hobble Creek Canyon, Sample #416	0.261	1590	1.14	0.36	240	n.d.	6.62	2.97	13.5	146
Rhizoplaca melanophthalma, Santaquin Canyon, Sample #417	0.083	294	0.238	12.2	331	n.d.	6.4	3.97	9.86	16.9
Xanthoria polycarpa, Santaquin Canyon, Sample #418	0.165	731	0.845	0.367	433	10.7	7.29	4.65	15	110
Xanthoria polycarpa, Battle Creek Canyon, Sample #424	0.316	1360	1.2	0.486	379	11.1	9.62	4.61	16.9	165
Xanthoria polycarpa, Battle Creek Canyon, Sample #425	0.299	1520	1.14	0.53	281	10.2	7.69	3.3	14.3	133
Rhizoplaca melanophthalma, Brunnells Fork, Sample #426	0.053	118	0.408	7.6	787	24.6	22.3	11.9	6.75	37.6
Rhizoplaca melanophthalma, Timp. basin, Sample #427	0.18	189	0.496	3.2	640	15.7	12.1	4.73	14.2	76.9
Rhizoplaca melanophthalma, Box Elder Peak, Sample #428	0.107	142	0.278	9.34	321	12.9	10.3	5.74	7.85	30.3
Xanthoria polycarpa, Tr. #044-Box Elder Pk., Sample #429	0.172	1020	0.896	0.292	155	6.27	3.73	2.34	6.69	74
Xanthoria polycarpa, Vicinity of Sterling Hollow, Sample #444	0.187	747	0.69	0.397	272	n.d.	7.23	2.86	13.7	92.5

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)								
	Pb	**Mn**	**Fe**	**Co**	**As**	**Se**	**Br**	**Rb**	**Sr**
Rhizoplaca peltata, Rock Canyon mines, Sample #404	173	42.8	3810	n.d.	9.89	n.d.	5.65	11.1	98.8
Rhizoplaca peltata, Rock Canyon, Sample #405	96.8	80.4	5640	n.d.	5.45	n.d.	8.55	20	86.2
Xanthoria polycarpa, Rock Canyon-RC camp, Sample #406	26.2	96.3	3630	n.d.	5.04	n.d.	12	9.64	25.9
Xanthoria polycarpa, Rock Canyon-RC camp, Sample #407	6.94	61.6	2020	n.d.	3.02	n.d.	13.8	7.63	20.6
Xanthoria polycarpa, Gardner Canyon, Sample #408	20.3	68	3030	n.d.	4.04	1.9	16.5	14.5	38.7
Rhizoplaca peltata, American Fork Canyon, Sample #409	48.8	88.9	4250	n.d.	6.08	n.d.	8.3	20.5	91.7
Rhizoplaca peltata, American Fork Canyon, Sample #410	213	58.6	4630	n.d.	n.d.	n.d.	8	13.3	107
Rhizoplaca peltata, American Fork Canyon, Sample #411	133	57.1	4990	n.d.	5.52	n.d.	7.54	13.7	79.9
Xanthoria polycarpa, American Fork Canyon, Sample #412	53.8	134	5120	n.d.	5.65	n.d.	23.8	14.6	30.8
Xanthoria polycarpa, Silver Lake Flat, Sample #413	9.96	153	2790	n.d.	5.16	n.d.	20.9	40	27
Lecanora sp., Silver Lake Flat, Sample #414	70.7	409	16800	n.d.	8.71	n.d.	n.d.	133	380
Rhizoplaca melanophthalma, Hobble Crk., Sample #415	94.2	37.7	3100	n.d.	4.38	1.32	2.88	14.8	32.4

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)								
	Pb	Mn	Fe	Co	As	Se	Br	Rb	Sr
Xanthoria polycarpa, Hobble Creek Canyon, Sample #416	13.9	127	2360	n.d.	3.43	n.d.	12.9	16.1	30.3
Rhizoplaca melanophthalma, Santaquin Canyon, Sample #417	94.9	29.5	2460	n.d.	n.d.	n.d.	5.25	11.8	114
Xanthoria polycarpa, Santaquin Canyon, Sample #418	17.6	78.8	3360	n.d.	4	1.27	12.4	20	27.9
Xanthoria polycarpa, Battle Creek Canyon, Sample #424	27.8	157	4360	n.d.	5.25	n.d.	16	16	40.8
Xanthoria polycarpa, Battle Creek Canyon, Sample #425	13.1	101	3090	n.d.	5.53	n.d.	18	29.1	41.3
Rhizoplaca melanophthalma, Brunnells Fork, Sample #426	24.1	71.2	6240	n.d.	7.37	n.d.	8.98	22.8	110
Rhizoplaca melanophthalma, Timp. basin, Sample #427	67.8	61.9	4570	n.d.	5.93	n.d.	12.6	22.1	52.5
Rhizoplaca melanophthalma, Box Elder Peak, Sample #428	43.8	25.5	2380	n.d.	3.59	n.d.	11	7.42	138
Xanthoria polycarpa, Tr. #044-Box Elder Pk., Sample #429	12.1	113	1570	n.d.	1.32	n.d.	12.5	11.8	23.8
Xanthoria polycarpa, Vicinity of Sterling Hollow, Sample #444	24.9	226	2930	n.d.	4.34	n.d.	8.99	16.6	30.9

Fig. 2 Lichen Biomonitoring Program and Baseline

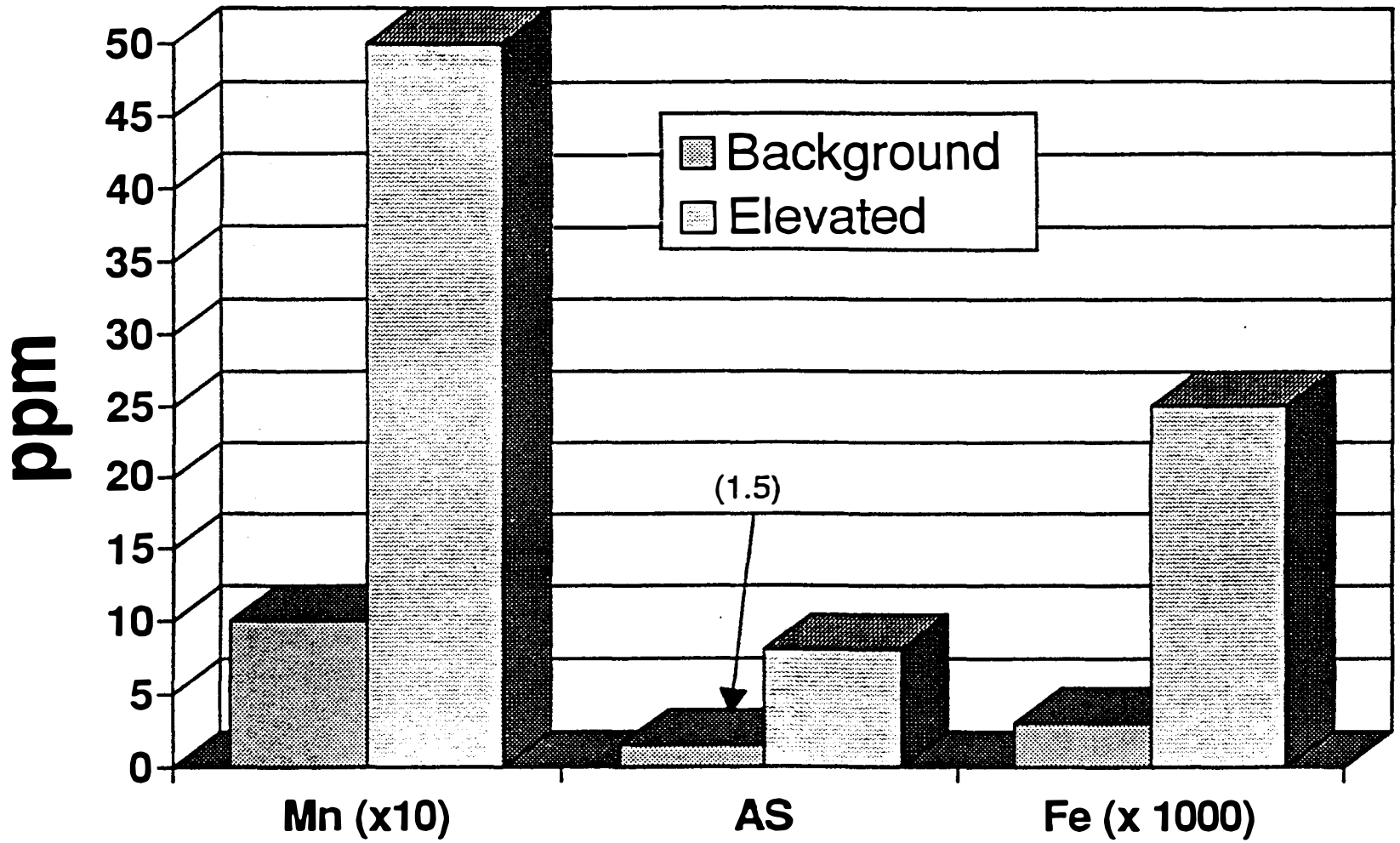


Fig. 2 cont. Lichen Biomonitoring Program and Baseline

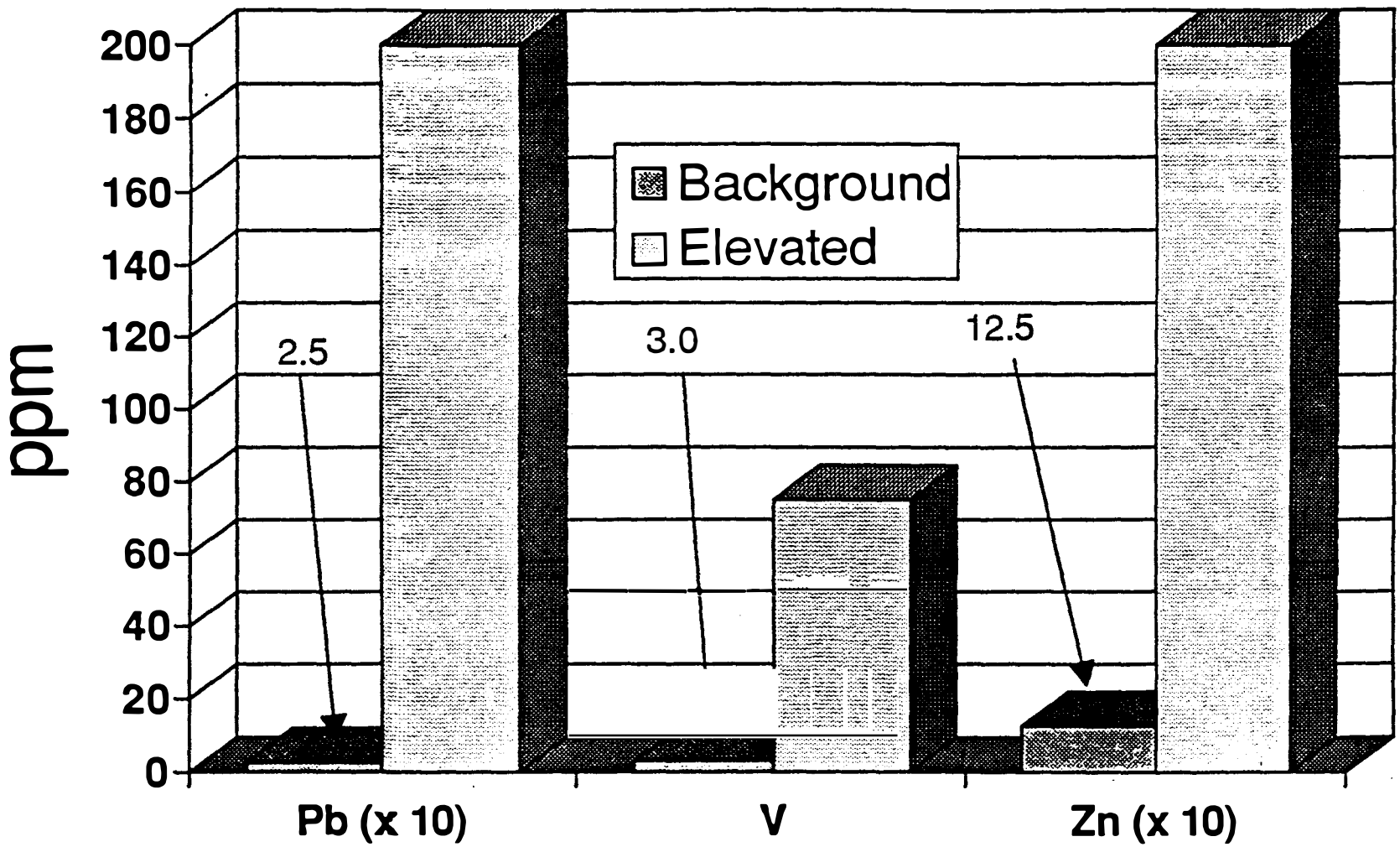
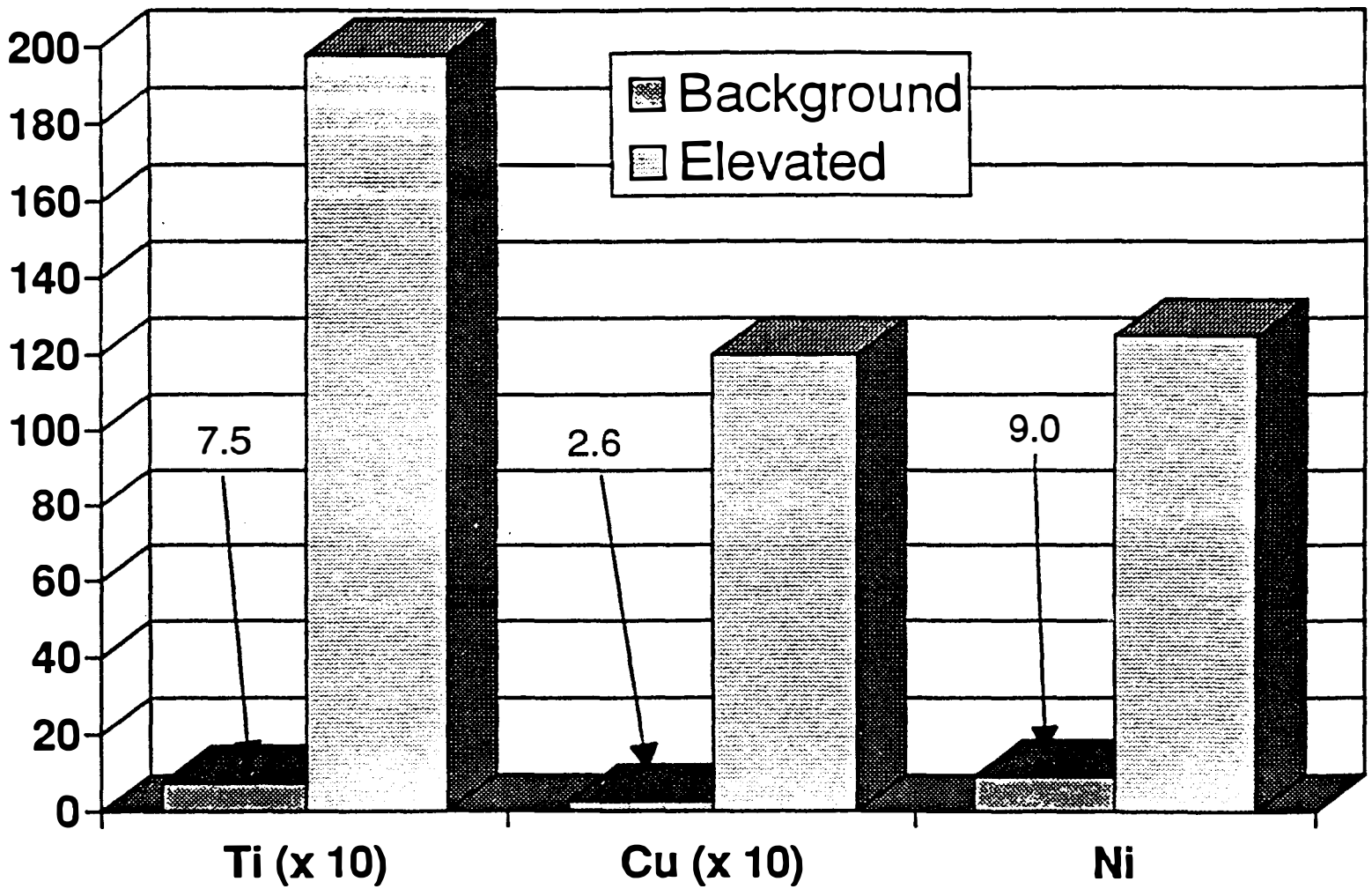


Fig. 2 cont. Lichen Biomonitoring Program and Baseline



Elemental Analysis Data
(background and elevated pollutant levels)

we recommend that a transplant study, using *Rhizoplaca melanophthalma* a common, saxicolous lichen which is sensitive to various pollutant elements, be established at several locations throughout Utah Valley. This type of study would be helpful in gathering critical elemental analysis, chlorophyll *a*, membrane permeability, and photosynthetic rate data using a sensitive indicator species. These data could then be used to more effectively evaluate air pollution effects on lichen communities in adjacent wilderness areas.

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